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*Semi Annual*

*Covering the Period July 1, 1970 - December 31, 1970*

**ACTIVITIES OF THE NASA-SPONSORED  
SRI TECHNOLOGY APPLICATIONS TEAM  
IN TRANSFERRING AEROSPACE TECHNOLOGY  
TO THE PUBLIC SECTOR**

*Prepared for:*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
TECHNOLOGY UTILIZATION DIVISION  
ROOM 402, REPORTERS BUILDING  
300 SEVENTH STREET, S.W.  
WASHINGTON, D.C. 20546

Attention: MR. ROYAL G. BIVINS, Jr.  
CODE UT

CONTRACT NASw-1992

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Menlo Park, California 94025 • U.S.A.



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*January 1971*

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## ACTIVITIES OF THE NASA-SPONSORED SRI TECHNOLOGY APPLICATIONS TEAM IN TRANSFERRING AEROSPACE TECHNOLOGY TO THE PUBLIC SECTOR

*By:* JOSEPH G. BERKE

*Prepared for:*

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SRI Project PAU-8368

## ABSTRACT

The NASA Technology Applications Team at Stanford Research Institute has been active in the technology transfer program since July 1, 1969, under Contract NASw-1992. The SRI Technology Applications Team has been working in the areas of Criminalistics, Transportation, and Air Pollution. The team is staffed by:

Charles J. Cook, Ph.D., Supervisor  
Executive Director, Physical Sciences Division  
Joseph G. Berke, M.S., Project Director and Transportation  
Brian Parker, D.Crim., J.D., Criminalistics  
Aryeh H. Samuel, Ph.D., Criminalistics  
Paul V. Roberts, Ph.D., Air Pollution  
Richard O. Blunt, B.S.M.E., Transportation  
Ruth M. Lizak, Research Assistant

In addition, an advisory committee provides continued guidance and direction to the Technology Applications Team effort.

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I. AGENCIES CURRENTLY UTILIZING SERVICES  
OF THE TECHNOLOGY APPLICATIONS TEAM

Alameda County Sheriff's Office Pleasanton, California	Highway Safety Research Institute Ann Arbor, Michigan
Bay Area Air Pollution Control District San Francisco, California	Institute of Traffic and Transportation Engineering Richmond, California Los Angeles, California
California Department of Agriculture Sacramento, California	International Association of Chiefs of Police Washington, D.C.
California Division of Bay Toll Crossings San Francisco, California	Long Beach Police Department Crime Laboratory Long Beach, California
California Division of Highways Sacramento, California	Los Angeles County Air Pollution Control District Los Angeles, California
California Medical Facility Department of Corrections Vacaville, California	Los Angeles County Department of the Chief Medical Examiner-Coroner Los Angeles, California
Center for Urban Regionalism Kent, Ohio	Los Angeles County Sheriff's Office Los Angeles, California
Contra Costa County Office of the Sheriff-Coroner Martinez, California	Los Angeles Police Department Scientific Investigations Division Los Angeles, California
Criminal Identification and Investigation Bureau Sacramento, California	Marin County Sheriff's Office San Rafael, California
Fairbank Highway Research Station Washington, D.C.	Montana Highway Commission Helena, Montana
Federal Highway Administration Washington, D.C.	National Highway Traffic Safety Administration Washington, D.C.
Federal Railroad Administration Washington, D.C.	Oakland Police Department Criminalistics Section Oakland, California
Highway Research Board Washington, D.C.	
Highway Safety Research Center Chapel Hill, North Carolina	

Ohio Highway Transportation  
Research Center  
East Liberty, Ohio

Orange County Coroner's Office  
Orange, California

Orange County Sheriff's Office  
Santa Ana, California

Pennsylvania Department  
of Transportation  
Harrisburg, Pennsylvania

Riverside County Sheriff's Office  
Riverside, California

Sacramento County Coroner's Office  
Sacramento, California

Sacramento County  
Office of the District Attorney  
Sacramento, California

Sacramento State College  
Sacramento, California

San Bernardino County  
Sheriff's Office  
San Bernardino, California

San Francisco Coroner's Office  
San Francisco, California

San Francisco Police Department  
San Francisco, California

San Jose Departments of Public Works  
and Traffic Engineering  
San Jose, California

San Mateo County Sheriff's Office  
Redwood City, California

Santa Clara County  
Laboratory of Criminalistics  
San Jose, California

Southern California  
Rapid Transit District  
Los Angeles, California

Transportation Systems Center  
Cambridge, Massachusetts

U.S. Department of Transportation  
Washington, D.C.

Walter Reed Army Institute  
of Research  
Washington, D.C.

Washington State  
Department of Highways  
Olympia, Washington

## II. POTENTIAL APPLICATIONS

During this reporting period, seven pieces of technology have reached potential transfer status. This category embraces technology that the team has matched to problems of user agencies but that the users have not implemented into their operating procedures. Reasons for this lack of implementation are many. The NASA technology may require modification to comply with the user's constraints and specifications. Perhaps the unit or device is "one of a kind," and a means must be developed for producing more. Funding is always a problem, and any good intentions of the user may be a fiscal year away.

The seven potential transfers reached during the first half of this contract year are described on the following pages.

Potential Application Report for Problem SRI/C-1  
"Measuring Reflection Spectra of Very Small Samples"

TA Team Personnel: A. H. Samuel and B. Parker

Criminalists often need to identify an automobile from a small amount of paint scraped at the scene of a crime. This applies in most cases to hit-and-run accidents where paint chips are recovered near the victim. Sometimes several square centimeters of paint are recovered, sometimes only a millimeter or so. Current laboratory procedure calls for visual comparison of the evidence with sets of standard paints supplied by car manufacturers, using a binocular microscope.

A solution to this problem was received from Dr. Fred Paul of Goddard Space Flight Center (Figure 1), as follows:

"Measurement of the reflectance spectrum of small samples can be accomplished in spectrophotometers which use an integrating sphere by inserting, in place of the usual sample, a plate carrying a standard microscope objective at the focal point at which the small sample to be measured is placed.

"The microscope objective serves to convey the illuminating beam to the sample and to return the reflected light to the integrating sphere. For the smallest sample mentioned (1 mm square) a 10 x NA 0.25 objective would be satisfactory. This costs about \$25. Making a fitting for the sample port of the integrating sphere and a means of holding

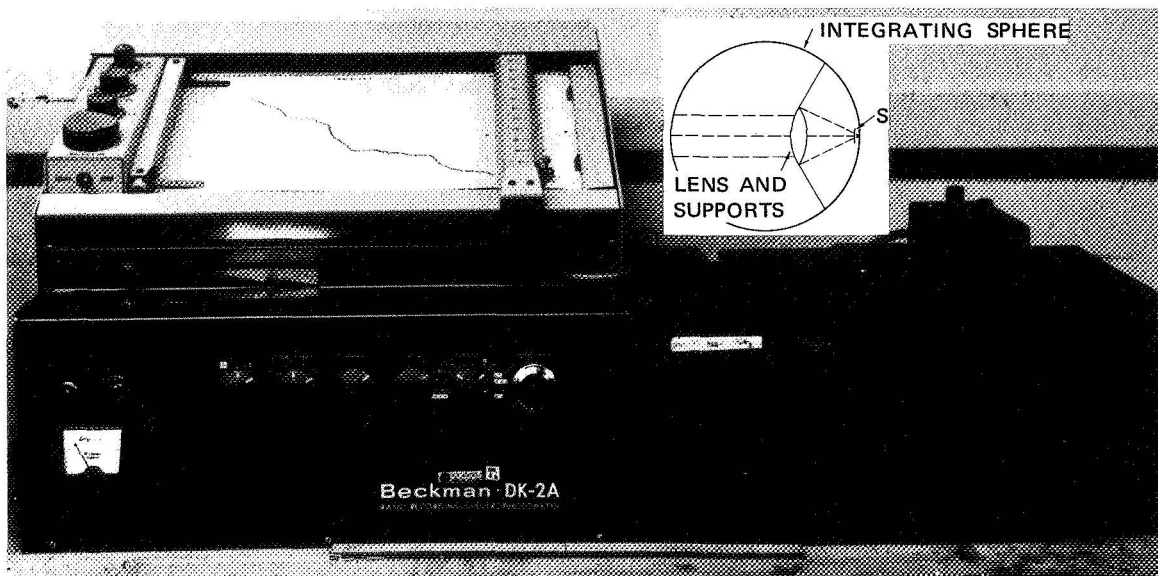


FIGURE 1 PAINT CHIP ANALYSIS

the small sample at the focal point of the objective is not likely to be expensive.

"The spectrophotometer with the small sample attachment would require a new photometric calibration. This can be accomplished by modifying the comparison beam or by inserting in the small sample compartment a standard of known reflectance characteristics, e.g., smoked magnesium oxide. This recalibration can be effected without changing the calibration of the unit for its normal use. That is to say, removal of the small sample attachment can return the instrument to its normal use condition without further adjustment. Thus, the proposed system is inexpensive, easy to calibrate, and does not have any adverse effect on the spectrophotometer to which it is attached."

The solution was presented to the users who were enthusiastic but lacked the equipment, time, and staff to perform any evaluation of the suggestion. Finally, after a long waiting period for user evaluation, the TA Team obtained paint samples from the crime laboratories and gave them to Dr. Paul, who then demonstrated the feasibility of his suggestion. Dr. Paul examined only three samples and established the need for more adaptive research. These experiments were performed in November 1970.

There may be many additional uses for this technique in performing various matching duties in and around a crime laboratory.

Current Status: The method is feasible and has been demonstrated. Additional research, preferably performed under the guidance of Dr. Paul at GSFC, is required to describe completely the method, the equipment, and the resolution of the system. The TA Team working with Dr. Paul and GSFC hopes to publish this information in a criminalistic journal. This would provide the crime laboratories with a justification for the purchase of necessary equipment and the incorporation of this technology into their daily operating procedures.

Impact on the Public: Based on the experience of our criminalist on the Team, and in conversation with the crime laboratories, the following information was prepared:

Of the 50,000 fatalities annually, if only 0.5%, or 250 cases, were decided by unquestionable physical evidence and never brought to trial, the savings to the public would be as follows:

	<u>No Physical Evidence</u>	<u>Physical Evidence</u>
Laboratory Costs	0	$\frac{1}{2}$ Man Day
Investigations	3 Man Days	3 Man Days
Legal Costs	2 Man Days	$\frac{1}{2}$ Man Day
Trial Costs (20 people/day, 5 day average)	100 Man Days	0
	<hr/> 105 Man Days	<hr/> 4 Man Days

Savings: 101 man days/case at \$5/hr = \$4040/case (assuming 0.5%  
of 50,000 fatalities come to trial) = \$1,000,000/yr.

In addition, there are more than 1,000,000 injury accidents without fatalities. Many of these also require criminal investigations in which similar savings per case are possible. Also, most fatality and serious-injury accidents give rise to civil damage suits. Correct identification of the tort-feasor will bring about a judgment that averages \$100,000 in fatality cases and a proportionate amount in injury cases. Thus, the value estimate given in the table is very conservative.

Potential Application Report related to Problem SRI/C-12  
"Morphine Analysis in Urine Samples"

TA Team Personnel: B. Parker

Mr. Ronald J. Philips of NASA-TUD contacted Ames Research Center and asked them to consider the New York City problem of analyzing morphine-containing urine from suspected heroin users. Urine samples are collected and are analyzed by private firms. Although the laboratory analysis requires only three hours, these firms receive the samples late and cannot return the results in less than three days from sampling. For legal or practical reasons, the suspects cannot be held for that length of time and are often released before the analytical results are received. The question posed is: Can the analysis be accelerated and still meet evidential requirements?

Discussions within and between the groups directed by Dr. John Parker and Mr. John Dimeff took place during the week of December 6th and were

attended by SRI TA Team representative Dr. Brian Parker. One discussion included a representative from the California State Bureau drug laboratory in San Francisco, Mr. Charles Hall. The outcome of the discussions was a plan to write a proposal for an automatic device capable of providing on-the-scene analysis of a urine specimen.

Dr. John Parker has taken the lead in preparing the proposal draft. The SRI TA Team will evaluate this draft with respect to forensic needs and transfer the technology to the users.

Basically, the proposal will advocate a column capable of complexing the morphine specifically. This morphine complex will activate an automatic sensing transducer. In addition, the characteristic rate of displacement of the morphine along the column will be measured. These two characteristics, chemical and physical, give sufficient information to identify morphine.

Successful completion of this proposed work would be another solution to SRI/C-12. It would open another line of development for an analyzer to detect all drugs through a generic mode of molecular interactions.

#### Potential Application Report for Problem SRI/C-22

"Simple Methods of Analysis for Metals and Metal Products"

TA Team Personnel: B. Parker

The solution was discovered from manual searches of the Tech Briefs--TB 70-10520 from Langley Research Center. The TA Team experience in criminalistics enabled the recognition of this brief as a possible solution to a problem in crime laboratories. The solution was presented to a local user for evaluation and comment. It consisted of a scheme for chemical spot testing. This scheme is embodied in a Langley publication\* that has been circulated to several criminalistic laboratories.

Metal objects are frequent items in criminal cases, e.g., obliterated serial number plate, toolmark on lock, bomb fragments. Determination of metallic composition can facilitate other analyses as well as serve to



identify the source. A spectrographic approach is not always available in crime laboratories, whereas a wet chemical approach is easily utilized.

Common chemicals, either laboratory stock items or easily obtainable, should constitute the necessary reagents. The method should be rapid in most instances, with a complete analysis taking less than an hour. The metal object should be essentially undamaged.

Current Status: As soon as standards are available, the laboratories will incorporate this NASA technology into their operations. The TA Team will attempt to obtain the means to provide the laboratories with standards, by purchasing rod stock of certified metals, 1- to 2-in. dia. These would be cut into  $\frac{1}{4}$ - to  $\frac{1}{2}$ -in.-thick specimens. We propose to use the common metals described in the support package of the brief--roughly 75 different metals. In addition the TA Team advisors at the Institute could perform tests on the method and perhaps hold a one-day seminar for the local crime laboratory personnel.

Impact: This impact is essentially similar to that of SRI/C-1. Any cases that can be settled without court trials will result in great savings to the public and will provide the laboratories with another tool for quick apprehension of perpetrators.

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\* Technical Support Package for TB 70-10520, "Nondestructive Rapid Identification of Metals and Alloys by Spot Tests."

Potential Application Report for Problem SRI/T-19

"Nondestructive Measurement of the Thickness of Portland Cement Concrete Pavements"

TA Team Personnel: J. G. Berke

The necessity for a nondestructive measuring device is relevant to both newly-constructed pavements and older ones. For new construction, the requirement is based on ensuring that construction specifications have been met before final payment to the contractor. For example, if the concrete thickness is reduced by  $\frac{1}{4}$  inch, a contractor could reduce his cost by approximately \$2000/mile, assuming a 40-ft-wide highway and concrete costing \$12/cubic yard. Current measurement methods require coring of the slab after the pavement has set. There are no methods available that monitor the pavement thickness as it is applied. On the interstate highway system alone, where 43,000 miles of completed highway represent 65% of the total, cores are taken every  $\frac{1}{4}$  mile, at a cost of \$30 per core. At this coring rate, it would cost about \$2.7 million for this one function on the remaining 22,000 miles. The cost would be even greater if we consider all new roads to be built and maintained thereafter. In addition, a great deal of data can be rapidly collected on the wearing properties of concrete, the effects of weather conditions, the effects of various de-icing chemicals, and the effects of tire wear to the pavement.

The importance of this matter has resulted in two projects sponsored by the National Cooperative Highway Research Program. The first programs in FY 64 and FY 65 were conducted with IITRI under the direction of K. E. Feith and S. D. Howkins. These programs included (1) study of all past and present methods of measuring thickness of highway pavements to determine whether any were suitable, (2) feasibility study of proposed methods then under development, (3) proposals for other feasible methods, and (4) recommendations for promising methods for development of instrumentation. This research resulted in the NCHRP Report No. 52, "Measurement of Pavement Thickness by Rapid and Nondestructive Methods."

The second program, funded for FY 71, will evaluate and field test existing systems of inspection testing to determine pavement thickness and reinforced steel position at the construction site, either before or after the concrete has hardened. The purpose of this program, under way with the Pennsylvania Department of Highways, is elimination or substantial reduction of the coring process. During this program, the state of Pennsylvania became aware of two NASA Tech Briefs:

TB 68-10183, "Detection and Location of Metallic Objects Imbedded in Non-Metallic Structures," June 1968.

TB 70-10107, "Detection and Location of Metal Fragments in the Human Body," February 1970.

The scientists are Robert L. Brown and Robert W. Neuschaefer of Marshall Space Flight Center. The briefs resulted from a NASA contract to detect the foam insulation thickness on the Saturn S-2 rocket stage (North American Aviation).

Pennsylvania contacted MSFC, and work was begun with Mr. Brown to develop this item further. The SRI TA Team was informed of this working relationship by the Highway Research Board in Washington, D.C., during a visit. The Technology Utilization Office at Marshall learned of this problem statement through one of our monthly reports.

This device (Figure 2) is basically an electronic metal detector, sensitive to the detector-metal distance; it detects a sheet of metal foil laid on the base course before paving. The foil can be of any inexpensive metal, 12 to 18 inches square with a minimum thickness of 0.02 mil. During this program the State of Pennsylvania actually prepared sections of their test track with foil to test the Marshall device and are now testing it along with many others. If this device is successful, it will be used in actual operation over a six-state paving program to test accuracy, reliability, and ease of operation under real conditions.

Mr. Brown of MSFC projects a commercial cost of about \$500 per unit. This is of great importance in the evaluation of the device because other potential units are selling for \$3000 and \$4000 each. A survey taken by



TA-8368-3

FIGURE 2 DEVICE FOR NONDESTRUCTIVE MEASUREMENT OF PORTLAND CEMENT CONCRETE PAVEMENTS

one manufacturer indicates that, even at \$4000, most states would buy about 20 devices.

The savings on road construction and maintenance across the country and perhaps the world certainly would be great.

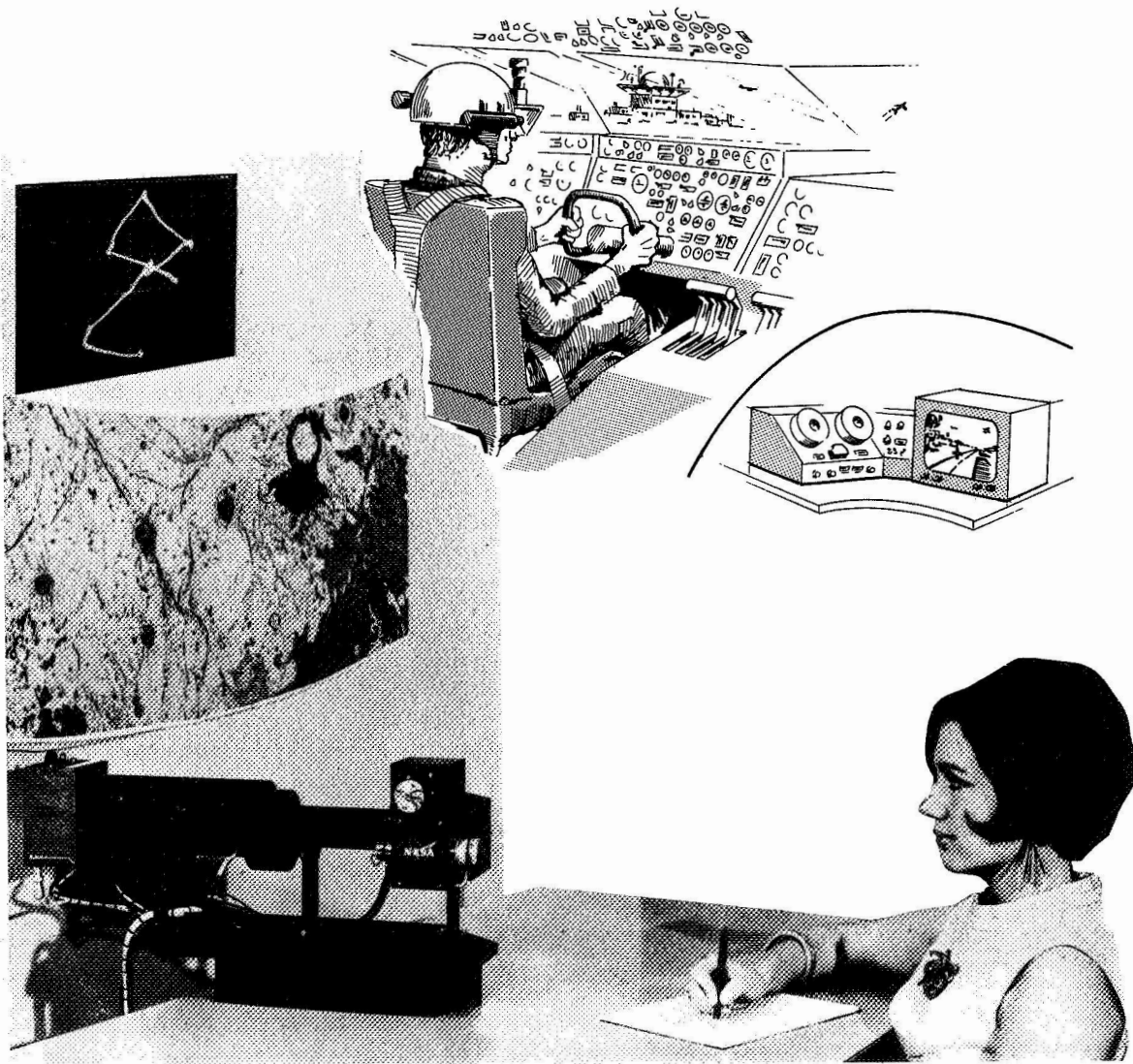
Current Status: This device is currently under evaluation by the University of Pennsylvania in conjunction with the State of Pennsylvania, Highway Department, working under a program with the Highway Research Board. The results of all the tests are to be completed by January 1971. Preliminary indications seem favorable; however, until the evaluations are complete, no information will be released.

Potential Application Report for Problem SRI/T-43

"Portable Device for Recording Eye Motion"

TA Team Personnel: J. G. Berke and B. Parker

A description of a table-mounted oculometer (Figure 3) was uncovered in NASA publication "Medical Benefits from Space Research," page 14. A call to the Technology Utilization Office of Electronics Research Center disclosed that this oculometer was developed for ERC, under Contract NAS 12-531, by Honeywell Radiation Center, Lexington, Massachusetts. A summary report was issued by John Merchant of Honeywell in October 1969.



TA-8368-4

FIGURE 3 PORTABLE DEVICE FOR RECORDING EYE MOTION

When approaching a highway sign, do you read it from bottom to top, or from right to left? Do the colors or the letter sizes, or both, affect the sign's effectiveness? Do flashing lights near a highway sign significantly distract you? These are questions of interest to researchers in the highway sign area.

In conjunction with the above questions, one must also take into account the effects of fatigue, narcotics, and pollution on the driver's ability to follow signs and other informational material along the highway.

To study these variables under field conditions, it is desirable to provide a driver with a head-mounted device to monitor eye motion and relate it to the visual scene. Current devices include a motion picture camera with a split view--one of the eye and one of the road ahead--that monitors eye motion. This is sufficient for gross eye motion. However, for information on the effects of fatigue, narcotics, or pollution, we must also study the physiological variables such as pupil dilation, blink rate, pupil position, and the relationship of these to the mental alertness of the subject.

A device such as the one being developed by the Federal Aviation Administration based on the above-mentioned NASA development would also be invaluable in the area of criminalistics. For instance, after some adaptive studies the device could be used as a noncontacting polygraph for criminal work. It also could be used as a stress level indicator by studying eye motion. A monitoring system could be installed at airline ticket counters to detect potential hijackers by abnormal stress levels.

As an educational tool, the device could monitor the visual intake of a cruising patrol officer. It could also record what a criminalist looks for in a crime scene. Users of either a table-mounted or a portable oculometer would be plentiful in just the areas of criminalistics and transportation.

Potential Application Report for Problem SRI/T-47

"Sewage Processor for Highway Rest Stops"

TA Team Personnel: J. G. Berke

Throughout the country, especially along the interstate highway system, a series of rest stops is being constructed to provide the travelling motorist with a comfort station, a place to spend the night, and so on. Since most of these stops are in rural areas, some thought must be given to preserving the ecological surroundings by thoroughly processing the sewage effluent from the comfort station.

Currently the problem is being handled by two methods. The first is to locate septic tanks or leaching fields near the rest stations. However, local health regulations impose certain requirements for constructing the septic areas. In many cases, the location and ecological surroundings do not allow compliance with the regulations. A second method uses chemicals and holding tanks. This method requires frequent servicing and transporting of the sewage to central processing plants miles away from these rural rest stops. In addition, the odor problem between servings becomes a factor at heavily used rest stations.

It is currently estimated for Montana that 500 persons use the comfort station facilities each day during the peak season. In other more populated, highly travelled areas, the number may be 1500 per day. Electricity and gas are available at the rest stops for power, so the unit need not be self-powered.

Evaluation of the computer search revealed the existence of a Hydro John waste management system (Figure 4) being developed for NASA by General Electric Space Division at Valley Forge, Pennsylvania. This system uses heat treatment to convert the sewage to unobjectionable products. Conversations and correspondence are being carried on between General Electric and the Manned Spacecraft Center in Houston to determine what needs to be done, both technically and administratively, to make a down-to-earth unit that meets the requirements of the highway departments.

Impact: The computer search material left with them for evaluation saved the State of Montana \$15,000 in research costs (see attached letter).

Future Impacts: A device such as the Hydro John could be valuable to both the biomedical and public sector agencies. In particular, it could serve the needs of the highway departments and the park departments to process sewage from rest stations, while preserving the ecological surroundings. In addition, there is potential use by transportation systems such as railroads and airlines.



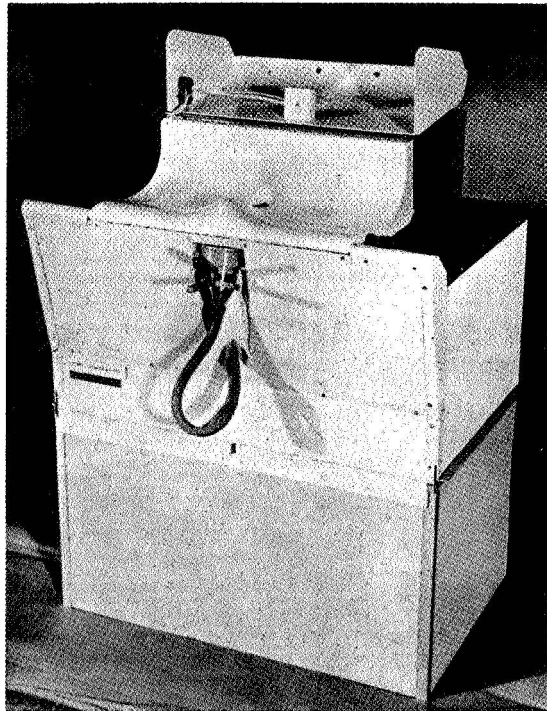
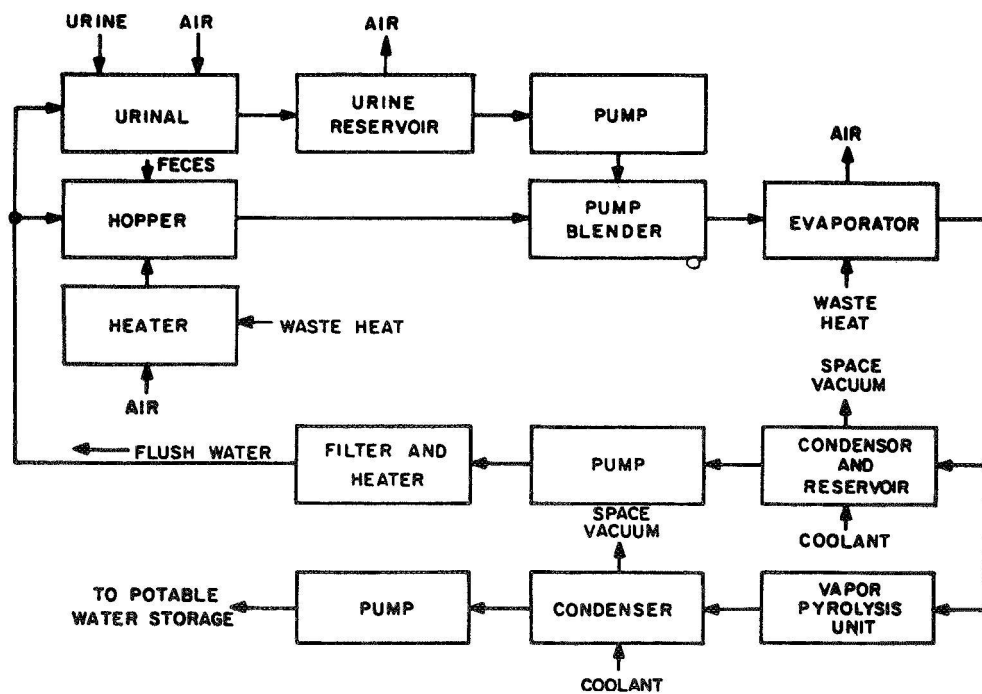
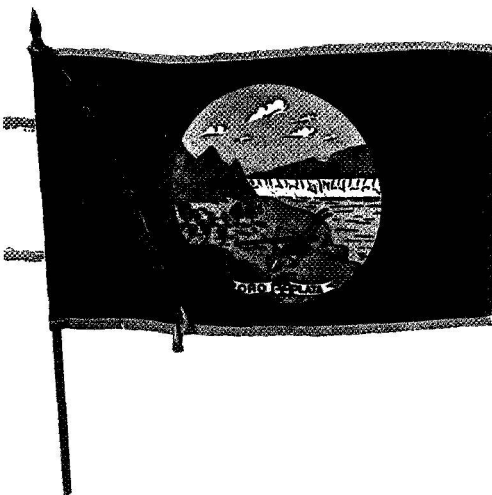


FIGURE 4a HYDRO JOHN SYSTEM LABORATORY PROTOTYPE



TA-8368-6

FIGURE 4b HYDRO JOHN SYSTEM BLOCK DIAGRAM



FORREST H. ANDERSON  
GOVERNOR

## MONTANA HIGHWAY COMMISSION

HELENA, MONTANA 59601

LEWIS M. CHITTIM  
STATE HIGHWAY ENGINEER

December 1, 1970

IN REPLY REFER TO:

26-ECM

Joseph G. Berke, Director  
Technology Applications Team  
Stanford Research Institute  
Menlo Park, California 94025

Dear Mr. Berke:

We certainly appreciated your visit to the Montana State Highway Commission and the information you retrieved from NASA files relative to research on the disposal of human wastes. Our problem of disposal without dangerous pollution must be solved if we are to provide the public with desirable rest areas adjacent to highways.

Your information was presented to Mr. Lewis M. Chittim, State Highway Engineer and a decision was made to reject a proposed research study and develop other sources of information such as General Electric's incineration units, etc. This will save us \$15,000 in research funds initially which was the estimated cost of Part I of the university's proposal.

Part I included a literature search, a study of other state agencies and a report on the "State of the Art". Part II, etc, would do actual research, if required. We now believe that sufficient information is available to solve the problem.

Many problems also exist in road maintenance as more and more improved mileage is added to our system. Keeping traffic control signing bright and more weather resistant, mechanizing patching of asphalt highways by using infra red or other heat sources in a manner that will thaw frozen surfaces sufficiently to apply hot asphalt materials to the patch and make it permanent and the removal of ice and hard packed snow with radio-isotope thermal energy or other suitable high energy source are a few of the critical needs of the transportation system to keep the nation's highways safe and convenient for the public.

I am sure that a list of problems other transportation agencies have asked about would be extremely valuable to each state highway department for many have like problems and will be interested in possible solutions.

I am returning the computer listing and wish to thank you again for your service.

Very truly yours,

LEWIS M. CHITTIM, P.E.,  
State Highway Engineer

By   
Edward C. Miller, P.E.,  
Research Engineer

ECM/vs

Enclosure

### III. CONCLUSIONS

The past six months have shown a marked increase in user acceptance of the Technology Applications Team program at SRI. This can be measured by the increasing number of calls received by the TA Team from user agencies with current problems. Referrals from current users to new users are increasing as well. Users are providing their own technological help and, when necessary, materials for testing against new technology.

On the NASA side, the same increasing interest is evident. Personal contacts with the center scientists and engineers are growing, and the discussions about problems are covering more relevant information. The NASA staff members, we feel, are developing an increasingly positive outlook toward the TU program and are cooperating by helping with small feasibility studies and some adaptive engineering work.

We anticipate that the next six months will see the implementation of transferable technology and a general increase in substantive interaction and cooperation by all concerned to solve problems related to man's earthly needs.

Appendix A  
CURRENTLY ACTIVE PROBLEMS AS OF  
December 31, 1970

Status Code: (Problems are listed on the following pages.)

A. Problem Definition

Problem definition includes the identification of specific technology-related problems through discussions with user agency personnel and the preparation of problem statements using nondisciplinary terminology.

B. Information Searching

Information relevant to a solution is being sought by computer or manual information searching, or both.

C. Problem Abstract Dissemination

An information search has revealed no potential solutions, and a problem abstract is being circulated to individual scientists and engineers at NASA centers and contractor facilities to solicit suggestions.

D. Evaluation

Potentially useful information or technology has been identified and is being evaluated by the team or the problem originator, or both.

D' Reevaluation

The problem statement is being reevaluated by the user to determine continued interest or to update, or both.

E. Potential Transfer

Information or technology has been evaluated and found to be of potential value but has not been applied.

F. Follow-up Activity

A technology transfer has been accomplished, but further activity (i.e., documentation, obtaining experimental validation of utility, continuing modification, etc.) is required.

Problem Number	Problem Title	Status Code
SRI/AP-1	Measuring Stack Plume Opacity in Low-Density Plumes	
SRI/AP-2	Monitoring Reactive Hydrocarbon Pollutants in the Atmosphere	C
SRI/AP-3	An Improved Method for Monitoring Nitrogen Oxides in the Atmosphere	C
SRI/AP-4	An Objective Method of Assessing Odors in the Atmosphere	C
SRI/AP-5	Measuring Continuously the Particulate Background and the Source of Atmospheric Particulates	
SRI/AP-6	Analyzing Dispersed Aerosols and Tracing the Sources by Identifying Their Respective Particulate Fraction	C
SRI/AP-7	Monitoring Organic Vapors in the Atmosphere	C
SRI/AP-8	Studying Aerosols in the Laboratory and the Atmosphere	C
SRI/AP-9	The Role of Aerosols in Smog Formation	C
SRI/AP-10	A Rapid Inspection Technique for Testing Compliance of Motor Vehicles with Emission Standards	C
SRI/AP-11	Monitoring of Fluorides in the Atmosphere	
SRI/AP-13	Stabilizing Waste Piles Arising from Mining and Smelting Operations	C
SRI/AP-14	Continuous Measurement of Atmospheric Ozone	
SRI/AP-15	Development of an Atmospheric Beryllium Monitor	
SRI/AP-16	Sulfuric Acid Mist Collector	C
SRI/AP-17	Remote Sensing of Air Pollution Damage to Vegetation	B

Problem Number	Problem Title	Status Code
SRI/C-1	Measuring Reflection Spectra of Very Small Samples	E
SRI/C-2	Determining Immunological Properties in Physiological Materials	C
SRI/C-3	Enhancing of Contrast on Questioned Documents	E
SRI/C-4	Preserving Vaginal Swabs	E
SRI/C-5	Characterizing and Individualizing Hair	C
SRI/C-8	Digitization of Fingerprints	D
SRI/C-9	Comparison and Classification of Evidence Items	C
SRI/C-10	Determining the Age of Writing in Documents	C
SRI/C-12	Simple Analytical Methods for Drugs	E
SRI/C-13	Effect of Drugs on Driving Ability	C
SRI/C-14	Immobilization of Bombs	E
SRI/C-15	Characterization of Glass	E
SRI/C-16	Metal Detectors	E
SRI/C-18	Soil Identification and Individualization	A
SRI/C-19	Differentiating Human Beings by Sweat Analysis	A
SRI/C-20	Correlation of Tool Marks by Microtopological Analyses of Striae	A
SRI/C-21	Methods of Testing Tools for Agreement with Production Specifications	B
SRI/C-22	Simple Methods of Analysis for Metals and Metal Products	E
SRI/C-23	Cell-Free Homogenization of Tissue	A
SRI/C-24	Retrieval Methods for Toxicological Case Information	D
SRI/C-25	Photographic Methods for Surface Characteristics	B
SRI/C-26	Educational Methods in Analysis	B
SRI/C-27	Residues from Hand Sweat or Film	B

Problem Number	Problem Title	Status Code
SRI/T-1	Origin --Destination Pattern	D
SRI/T-2	Vehicle Locator	B
SRI/T-19	Nondestructive Measurement of the Thickness of Portland Cement Concrete Pavements	E
SRI/T-20	Culvert Deformation	D'
SRI/T-23	Measurement of Pavement Surface Texture	D'
SRI/T-24	Profile Measurement of Pavement Surfaces	D'
SRI/T-27	Reflective Signs	D'
SRI/T-32	Impact Data Analysis	C
SRI/T-35	On-Site Compression Strength Measurements of Structural Pavement Sections	D'
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Appendix B  
PRELIMINARY PROBLEM STATEMENTS  
for Current Problems

Air Pollution

SRI/AP-1 "Measuring Stack Plume Opacity in Low Density Plumes"

The present method for measuring stack plume opacity in low density plumes requires visual comparison by an expert against a set of standard panels known as the Ringelmann Chart. Ringelmann 1 is equivalent to 20% black and is the current legal limit in most urban areas. The number of sources continues to increase and, to maintain present visibility levels, plume opacity soon must be controlled at some fraction of a Ringelmann 1. This is beyond the capability of the subjective method now used.

SRI/AP-2 "Monitoring Reactive Hydrocarbon Pollutants in the Atmosphere"

An instrument for monitoring those hydrocarbon pollutants in the atmosphere that are reactive in photochemical smog would be much preferred to the total hydrocarbon monitors now used. Photochemical smog develops when nitrogen oxides and certain hydrocarbons are exposed to the sunlight. The different classes of hydrocarbons present in the atmosphere vary widely in their photochemical reactivity, ranging from methane, which is inert, to the olefins which are very reactive. A direct measurement of reactive hydrocarbons would be much more meaningful as an air pollution index than are the present methods of infrared absorption or flame ionization.

SRI/AP-3 "An Improved Method for Monitoring Nitrogen Oxides in the Atmosphere"

Current methods of analysis for atmospheric NO<sub>x</sub> are based on color development in solution. Wet chemical methods of continuous gas analysis have inherent problems and limitations that make them difficult to use. A technique based on some other property of nitrogen dioxide and nitric oxide is badly needed.

SRI/AP-4 "An Objective Method of Assessing Odors in the Atmosphere"

Odor problems in air pollution are difficult to assess because there is no general objective measurement technique. Standardization has been sought for a number of years. Because of the possible chemical complexity of odorous mixtures and the variability of human olfactory response, the problem is a difficult one. At present it is not possible to be quantitative or even qualitative in specifying odor limits or odor types.

SRI/AP-5 "Measuring Continuously the Particulate Background and the Source of Atmospheric Particulates"

A continuous measurement system is needed to provide rapid assessment of sources of particulates and of particulate background conditions. Particulate concentrations in polluted air are generally measured on a mass per unit volume basis by weighing the material collected on a filter over a relatively long period of time. Smoke density is measured very quickly by optical methods, but such methods cannot relate size distribution to mass concentration.

SRI/AP-6 "Analyzing Dispersed Aerosols and Tracing the Sources by Identifying their Respective Particulate Fraction"

Methods are needed for making critical identifying analyses of particulate material in urban air for determining the source. Although analysis of a number of possible elements may be of value, differentiation of the various carbons would have the greatest significance and be the best overall comparator.

SRI/AP-7 "Monitoring Organic Vapors in the Atmosphere"

Government standards for tolerable pollution levels are continually being established for particular pollutants, but available monitoring instrumentation does not necessarily identify discrete, important pollutants. Instruments that would continuously and separately determine olefins, aliphatics, and aromatics are urgently needed to monitor these specific hydrocarbons and determine tolerable levels. Instruments to monitor atmospheric aldehydes continuously are also needed.

SRI/AP-8 "Studying Aerosols in the Laboratory and the Atmosphere"

Aerosols may play an important role in smog formation. Instrumentation is needed for field and laboratory measurements of organic aerosols applicable down to low mass loadings and relatively small sample volumes.

SRI/AP-9 "The Role of Aerosols in Smog Formation"

The possible importance of aerosols in smog formation in other roles than as a light scatterer is just beginning to be realized. Aerosols may be a primary absorber and a particulate site for chemical reactions. Although there have been many subjective observations that eye irritation appears worse on days starting with a heavy fog and transforming into smog, little is known of the effect of fog in terms of chemical reactions leading to smog manifestations.

SRI/AP-10 "Rapid Inspection Technique for Testing Compliance of Motor Vehicle with Emission Standards"

More than 50 percent of air pollution in most urban areas arises from motor vehicle exhaust. An accurate, rapid, simple, standard, and routine procedure is needed for testing compliance of motor vehicles with emission standards.

SRI/AP-11 "Monitoring of Fluorides in the Atmosphere"

Fluorides are extremely toxic to animals and plants and are normally present in the stack emissions of aluminum and steel mills in gaseous or particulate form. Although a wide variety of plants is susceptible to fluoride damage, perhaps the more serious effect is on animals that may consume fodder containing relatively high concentrations of fluorides. A method is needed for monitoring atmospheric fluorides on a continuous or quasi-continuous basis.

SRI/AP-13 "Stabilizing Waste Piles Arising from Mining and Smelting Operations"

Huge quantities of waste, called tailings, arise from mining and smelting operations. These are very fine particles and are easily blown by the wind. Repeated wetting has been tried to control this blowing dust, but is not very effective due to evaporation of the water and the rapid rates at which the material accumulates.

SRI/AP-14 "Continuous Measurement of Atmospheric Ozone"

Daily ozone concentration maxima provide a direct, unambiguous index of photochemical smog. The monitoring methods that have been developed, however, are affected by other strong oxidizing components associated with the smog, such as nitrogen dioxide. An instrument is needed for continuous analysis of ozone.

SRI/AP-15 "Development of an Atmospheric Beryllium Monitor"

The extreme toxicity of beryllium oxide fumes is well known, and hazardous level beryllium contamination is a potential threat in the vicinity of rocket test facilities where beryllium fuel is burned. Under normal test conditions these facilities have the capability of removing essentially all of the beryllium fume from the exhaust gases before release to the atmosphere. However, the possibility of non-normal operation during testing as a result of malfunctioning of some system components makes urgent the need for a rapid response instrument to provide continuous beryllium concentration data with an alarm activated by toxic threshold concentrations.

#### SRI/AP-16 "Sulfuric Acid Mist Collector"

Sulfuric acid is formed as the oxidized end product in many industrial exhaust streams containing sulfur gases. It is an undesirable and highly visible air pollutant, scattering light so strongly that the apparent density of the plume is much greater than that of an equivalent water droplet plume. This built-in detector should be taken advantage of in developing a method to remove completely the sulfuric acid from stack gases.

#### SRI/AP-17 "Remote Sensing of Vegetation Damage"

Air pollution vegetation damage is an increasingly important problem in areas of the United States where photochemical and industrial smog occurrences are common. A device or system is needed to survey extensive areas of forest or field crops for air pollution damage, measuring the extent of damage and identifying the causative pollutant.

### Criminalistics

#### SRI/C-1 "Measuring Reflection Spectra of Very Small Samples"

A frequent problem in criminalistics is to identify an automobile from a small amount of paint left on an object it has scraped, especially in hit-and-run cases. Sometimes several square centimeters are left; sometimes only about a square millimeter. Identifying the paint can lead to identification of the make of car, and even the year and model sometimes.

#### SRI/C-2 "Determining Immunological Properties in Physiological Materials"

Materials are needed for identifying immunological properties (in addition to simple blood groupings) in physiological matter, particularly dried blood and blood stains. Many types of immunological classification are known for liquid blood. If these classification methods could be applied to blood stains and dried blood, detection and conviction of criminals would be aided.

#### SRI/C-3 "Enhancing of Contrast on Questioned Documents"

A nonreflective thin coating is needed to ascertain the ordering of writing at crossovers on questioned documents, when the question arises as to which of two crossing lines was written first. When liquid inks were in common use, this could be determined by the flow of ink from the later line into channels made by the passage of the earlier nib. This does not work with the much more viscous ball point inks. For examination with a scanning electron microscope, a thin gold coating

is applied, but its specular reflection makes microscopic examination very difficult. An optically dull substitute is desired.

#### SRI/C-4 "Preserving Vaginal Swabs"

Whenever a complaint is made that involves a possible prosecution for rape, a vaginal swab of the victim is secured. Experience shows that only a small fraction of the complaints develop into rape prosecutions. It would therefore be wasteful and prohibitively expensive to examine all these samples immediately. Preserving the samples at the point of origin is desired so that they can be examined when indictment is being considered--about one month.

#### SRI/C-5 "Characterizing and Individualizing Hair"

Among the most frequently found items of physical evidence are samples of hair. At present, it is not possible to establish positive identification on the basis of hair because only a broad classification can be obtained. It is desired that the possibility could be excluded that another person's hair would also match the sample.

#### SRI/C-8 "Digitization of Fingerprints"

Fingerprints are classified by a topological system (number of ridges between features) since successive prints of the same finger may vary in area covered and size. An automatic method is needed to record, classify, transmit, and retrieve fingerprints. At the present time most of this work is done manually.

#### SRI/C-9 "Comparison and Classification of Evidence Items"

An automatic comparison method is needed, not only to save time and labor, but also to create an objective record that can be introduced in evidence. This digital or analog system should be able to compare an item of physical evidence, such as a tool mark, bullet, or footprint, with a comparison item, and allow retrieval of matching items from a file.

#### SRI/C-10 "Determining the Age of Writing in Documents"

When documents were written in liquid ink, oxidative changes of the ink and reactions of its components with the cellulose and lignin of the paper permitted at least approximate dating. Ball point inks, however, are subject to very slow oxidation changes, and ink formulations include an oil-soluble or polyalcohol base, a dispersed polymer, and a dye or pigment. Information is needed that can lead to analytical methods for determining the age of such ink deposits.

#### SRI/C-12 "Simple Analytical Methods for Drugs"

There are two types of drug analysis: determination of the identity of seized samples and determination of drug levels in blood, urine, or other physiological specimens. The latter is much harder and may lead to wrongful convictions based on inferior evidence. Chemical separation procedures followed by gas chromatography, with collection of the effluents for infrared spectrophotometry or mass spectrometry, is a satisfactory method; however, most criminalistics laboratories do not have this equipment.

#### SRI/C-13 "Effect of Drugs on Driving Ability"

Illicit drugs, prescription drugs, and even some cold remedies that are sold over the counter can impair driving ability. However, law enforcement authorities have little or no quantitative information on their effects, especially as these relate to the manual skills, reaction times, and judgment factors. Such information would help obtain convictions of motorists who drive under the influence of drugs and might also, if widely disseminated, prevent people from driving dangerously.

#### SRI/C-14 "Immobilization of Bombs"

All large police forces have bomb squads to cope with bombs left by criminals. One element that is common to both crude and sophisticated bombs is an electric initiation, usually internal batteries. Dropping the bomb into lubricating oil requires moving the bomb and therefore is not considered safe. A disarming method is sought that does not involve moving the bomb.

#### SRI/C-15 "Characterization of Glass"

It is a deeply satisfying moment for an investigator when he can take a piece of glass found at the scene of a fatal hit-and-run accident and fit it precisely into the gap left in the broken headlight of the suspect's car. Unfortunately, the glass is usually shattered into fragments too small for reconstruction. Therefore, glass characteristics must be determined to compare with the known properties of glass in various makes of cars, including refractive index, elementary composition, and hardness.

#### SRI/C-16 "Metal Detectors"

Bullets, guns, keys, burglar's tools are some of the metal objects often sought during a police investigation. These may be imbedded in a wall or tree and may be ferrous or non-ferrous. Metal detectors designed to detect land mines are not satisfactory for investigative purposes. Apparently specially designed detection instruments are needed.

#### SRI/C-18 "Soil Identification and Individualization"

In the commission of a crime, the perpetrator often leaves or picks up soil. Where soil from the crime scene can be correlated completely with soil found on a suspect, the first step in individualizing the specimens is achieved. The second step is to consider the probabilities of the environmental distribution of soil constituents, including mineral matter, biological matter, and artificial matter. Since specimen quantities are frequently amounts producing a clothing smear or filling a shoe nailhole, a systematic method is needed to qualitatively and quantitatively characterize soil constituents in small samples.

#### SRI/C-19 Differentiating Human Beings by Sweat Analysis"

The stress during a criminal violation increases the chances that human sweat will be left at the scene through contact, such as fingerprints. Clothing left at the scene is apt to bear sweat stains. Information from an analysis of sweat is needed. This might include determination of human origin by precipitin test and blood group if a secretor (80% of population). Microscopic flora and fauna would bear consideration as to qualitative distribution among individuals.

#### SRI/C-20 "Correlation of Tool Marks by Microtopological Analyses of Striae"

Many crimes require the use of tools and these often leave marks. The microscopic variations, on the order of a microinch, in a crime scene mark and those of a mark made by a suspected tool are juxtaposed with a comparison microscope by present techniques. Low-angle incident light on the marks produces a hill-and-vale rendition of the striae. These are adjusted by relative movements to align the two marks, resulting in mismatches. A technique is needed for retrieving profile information from striae produced by tools and correlating profiles from the same tool at different times.

#### SRI/C-21 "Methods of Testing Tools for Agreement with Production Specifications"

In scientific crime detection, recovered tools or broken tool parts can provide clues to perpetrators if the tools can be traced to a manufacturer or fabricator or if the manufacturing mode can be specified. Where no trademark or other identification is available, a surface finished by a grinding wheel will present surface discontinuities that can be traced. Information on materials, forming procedures, and finishing techniques obtainable from the final tool product can be a tremendous aid to criminal investigation.

#### SRI/C-22 "Simple Methods of Analysis for Metals and Metal Products"

Metal objects are frequent items in criminal cases, e.g., obliterated serial number plate, toolmark on lock, bomb fragments. Determination of metallic composition can facilitate other analyses as well as serve to identify the source. A spectrographic approach is not always available in crime laboratories, whereas a wet chemical approach is easily utilized.

#### SRI/C-23 "Cell-Free Homogenization of Tissue"

The extraction of organic poisons (and their metabolites) from biological tissue is approached by techniques such as simple diffusion, mechanical rupture, and differential solubility. Since a qualitative identification is the first step, the extent of extraction is traded off or balanced against the speed, sensitivity, and specificity of analysis. If the subsequent purification is not unduly time-consuming, an automated system to rupture all cells in a single specimen would reduce the time necessary for operator attention and yield a more complete extraction.

#### SRI/C-24 "Retrieval Methods for Toxicological Case Information"

The number of drug abuse cases, fatal and nonfatal, is on the order of 2 million cases per year. A complete toxicological investigation is essential in each case of death and in many nonfatal cases, so that ultimately the roles, direct and indirect, of specific exogenous chemicals may be assessed. An information storage and retrieval system of a generalized nature is desired for data from toxicological cases.

#### SRI/C-25 "Photographic Methods for Surface Characteristics"

Surface characteristics are often difficult to photograph because of problems of reflectance or lack of contrast, or both. Crime laboratories frequently have very minute characteristics as important items of evidence (in addition to visual analysis).

#### SRI/C-26 "Educational Methods in Analysis"

Approaches to the analysis of an unknown are critical elements in the education of a forensic scientist. The need is expressed for methods designed to enhance the orientation of a scientist to, or to guide the development of a student in, the selection of retrieval schemes for the informational contents from an object of evidence.



#### SRI/C-27 "Residues from Hand Sweat or Film"

Fingerprints left at the scenes of crimes are usually invisible and are found on a variety of surfaces. Fairly precise information as to the nature of the film found on human hands and the deposits from that film on various surfaces is needed. With this information, new and improved methods can be formulated for detection and retrieval.

#### Transportation

##### SRI/T-1 "Origin-Destination Pattern"

A very inexpensive, portable device that could "mark" a bus passenger as he enters the bus and identify him as he leaves would make possible the development of equipment to record data on the origin and destination pattern and fare mix of a transit system. This would greatly aid in effectively routing and scheduling buses, and reduce the number of transfers.

##### SRI/T-2 "Vehicle Locator"

Transit operators, police, and highway patrols need an inexpensive device to track a vehicle and compute its location coordinates for automatic reporting to a central dispatcher. A system that would transmit the vehicle's location when interrogated by the dispatcher would permit identification of its location when the officer is occupied outside the vehicle.

##### SRI/T-19 "Nondestructive Measurement of the Thickness of Portland Cement Concrete Pavements"

It is necessary in both newly laid and older Portland cement concrete pavements to determine the thickness with some degree of accuracy. For new pavements, measurement is necessary to ensure that construction specifications have been met. For older pavements, load carrying capabilities must be assessed. A rapid, inexpensive, and accurate method is needed to measure the thickness of the finished Portland cement concrete pavements, by nondestructive means.

##### SRI/T-20 "Culvert Deformation"

Highway builders use a great many corrugated steel culverts to carry water through highway fills. The present design formulae were developed for culverts buried in light or moderate fill heights. These may be inadequate for the high fills used in many modern highways. Equipment is needed to measure the deformation of a steel culvert during placement of the fill and for several years thereafter.

#### SRI/T-23 "Measurement of Pavement Surface Texture"

The skid-resistance of automotive tires is a function of the surface texture of the pavement. Several methods have been developed to measure texture and correlate it with skidding and hydroplaning, but all are time-consuming to use. A rapid test, preferably electronic, is needed to measure the surface texture of highway pavement.

#### SRI/T-24 "Profile Measurement of Pavement Surfaces"

Today's modern highways demand smooth surfaces to provide for safety and comfort at high speeds. Surface tolerances for new pavement construction are ordinarily given in terms of a maximum allowable vertical deviation from a true plane in a given horizontal distance. A high speed, accurate, profile measuring device to be operated at maximum automobile highway speeds is needed.

#### SRI/T-27 "Reflective Signs"

Highway signs use retro-reflective materials in the form of sheets or plastic buttons, all having a smooth, transparent surface covering. When this surface is covered with dew, the refraction and scattering of light from the water droplets destroy the retro-reflective character of the material. A material or coating is needed to preserve these retro-reflective properties in dew-forming conditions.

#### SRI/T-32 "Impact Data Analysis"

Highway laboratories test automobiles and wayside structures under impact to develop structures offering durability and maximum protection to the driver. Data resulting from impact tests must be compared with a passenger survival criterion. Prior to being used for this purpose, the data must be reduced to meaningful terms. Descriptions of both analog and digital techniques involved in filtering noise, integrating, and computing are desired.

#### SRI/T-35 "On Site Compression Strength Measurements of Structural Pavement Sections"

The strength of a given concrete varies with a number of factors, the most important being compressive strength of the cement paste, gradation and strength of the aggregates, the mix proportions, the water-cement ratio, and curing methods. A rapid, cheap and accurate method is needed to measure the structural strength of the finished concrete pavement.

#### SRI/T-37 "Ultraviolet Degradation of Highway Signs"

Currently the reflective material used on highway signs degrades after a period of time due to exposure to the sun's ultraviolet radiation. A method or process or a new material is needed that will prevent or resist the degrading effects of ultraviolet radiation in reflective materials

#### SRI/T-38 "Detection of Incipient Roller Bearing Failure on Rail Cars"

Derailment is a typical consequence of bearing failure. A rate of failure that is tolerable in routine freight service will be intolerable in very high speed passenger service for which a lower friction, more reliable bearing than the journal bearing is necessary. Roller bearings are capable of long, trouble-free service, but they lack the early-warning characteristics of the journal bearing. Therefore, railroads follow strict rules about inspection procedures. In addition, bearings on cars that have been involved in collisions or derailment must be disassembled and inspected in an expensive shop operation. A device is needed to warn of incipient failure of roller bearings on rail cars.

#### SRI/T-39 "Detection of Lock-In Stress in Long Welded Rails"

Modern railroad track is laid in very long, continuous lengths of welded rails. Thermal stresses build up in such a strip, but are normally distributed along the rail. If ties, ballast, or anchors are disturbed by maintenance or repair work performed at a different temperature from that at which the rail was laid, stress may be relieved in one section and accumulate in another. On a hot day a sufficiently large compressive stress may build up to buckle the rail despite the lateral restraint by the ties and form a sun kink. A device is needed that can travel along a steel rail and measure its stress condition.

#### SRI/T-40 "Nondestructive Testing of Rail Butt Welds"

The quality of welds in continuous welded rail is very important to the safety of the resultant track. The shop welding process is fast. The welds are checked while still cooling by Magnaflux device; however, internal defects are easily missed. The ultrasonic test used in the field is not applied to shop welds because the necessary cooling time is too long. A nondestructive test is needed that can function with the rail at 500°F minimum, preferably to 900°F.

#### SRI/T-41 "Creation of Properly Scaled Levels of Wind Turbulence and Gust Velocities for Wind Tunnel Tests"

Techniques are needed for creating natural wind turbulence for spatial and temporal measurements in wind tunnels. Scale-model bridges, buildings, and so forth are studied with simulated wind conditions up to 100 mph. The model sizes are about 5 ft long and are studied in a 6-ft-square open throat wind tunnel.

#### SRI/T-42 "Instrumentation for Close Range Photogrammetry"

Measurement of the very slight motions of large structures such as bridge pilings, base structures, and large earth fills at distances of 20 to 200 ft is desired. In many cases, the item under study is inaccessible to routine types of instrumentation and measurement techniques.

SRI/T-43 "Portable Device for Recording Eye Motion"

A portable device is needed to monitor eye motion of vehicle drivers. How a highway sign is read, whether colors or letter sizes have an effect, whether flashing lights near a highway sign are distracting, and how fatigue, narcotics, and pollution combine with the other questions, are of interest to researchers in the highway sign field.

SRI/T-44 "Frost Detection and Removal from Bridge Decks"

Ice or frost on bridge roadways, at a time when the approach pavements remain ice- and frost-free, has been accepted as a safety hazard in many states. Because the bridge itself is exposed to moisture and winds from all sides, ice and frost generally form on the decks before appearing on the approaches. A detector is needed to indicate the formation of ice or frost on the roadway of a highway bridge. Also needed is a method, triggered by the detector, to remove such ice and frost.

SRI/T-45 "Nondestructive Testing of Large Metal Structures"

Methods are required to test large metal structures, especially bridges, for structural integrity. Solutions should consider the impedance to smooth traffic flow during testing, simplicity of the test and reliability of operation. There are approximately 500,000 bridges on U.S. highways and no definitive way to determine which ones are structurally safe.

SRI/T-46 "Improved Rear Vision Device"

The lack of a clear 180° rear view from vehicles poses a continuous safety problem. An improved rear vision device is needed for motor vehicles.

SRI/T-47 "Sewage Processor for Highway Rest Stops"

Since most highway rest stops are located in rural areas, some thought must be given to preserving the ecological surroundings by thoroughly processing the sewage effluent from the comfort station. A self-contained sewage processing unit is desired, requiring little maintenance.

SRI/T-48 "Expandable Telemonitoring System"

An expandable telemonitoring system is needed that is capable of expansion without adding appreciably to the cable size. Because of the large number of intersections in most cities, wires to the computer have limited the system. The composite cable is too large to tie to the computer.

SRI/T-49 "Air Purification for Toll Booths"

There is a need for an economically feasible system for providing purified air to toll booths in an environment having a high concentration of compounds from vehicle exhausts.

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